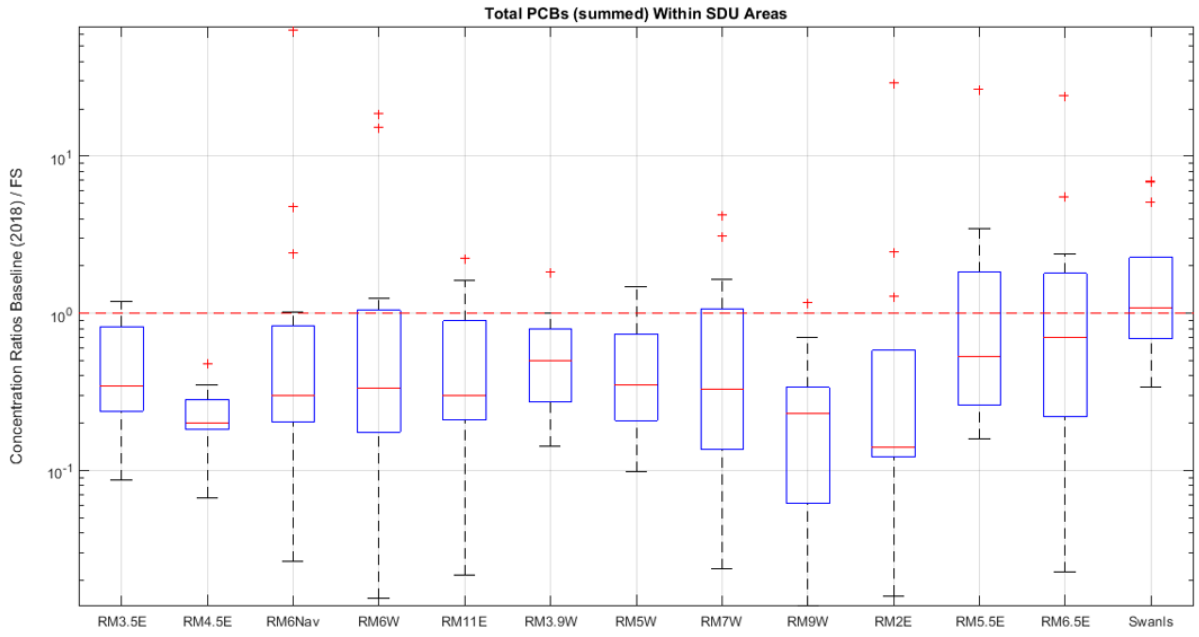
EPA Evaluations Used All Data in Dataset Comparisons

PDI, RI/FS, and Other Historical Data

- Surface Sediment
  - SMA delineation
  - RAL curves
  - Sediment decision unit (SDU) temporal change (paired difference method)
  - SDU temporal change ratio analysis **See illustrated example below**
  - Grid cell regression analysis
  - SWAC uncertainty evaluation
  - Dioxin/furan SMA delineation
  - Technology assignment selection
- Subsurface Sediment
  - 3-D SMA model
  - Evaluation of subsurface RAL exceedances outside of preliminary refined SMAs
- Surface Water and Sediment Traps
  - Qualitative comparison of concentrations
  - Qualitative comparison of mass loading estimates
- Fish Tissue
  - Smallmouth bass tissue temporal change analysis sitewide and by proposed river segment
  - Surface sediment/fish tissue spatial regression analysis
  - COC versus percent lipid regression analysis
- Fish Tracking
  - Comparison between PDI fish tracking results and 2000 to 2003 ODFW study
- Bathymetry
  - Absolute bathymetric elevation change (2002 to 2009; 2009 to 2018; 2004 to 2018)
  - Cumulative sediment deposition score
  - Deposition in ROD SMAs – 2004 to 2018

Illustrated Example: Ratio Comparison of Debiased PDI and RI/FS Surface Sediment Data for Total PCBs

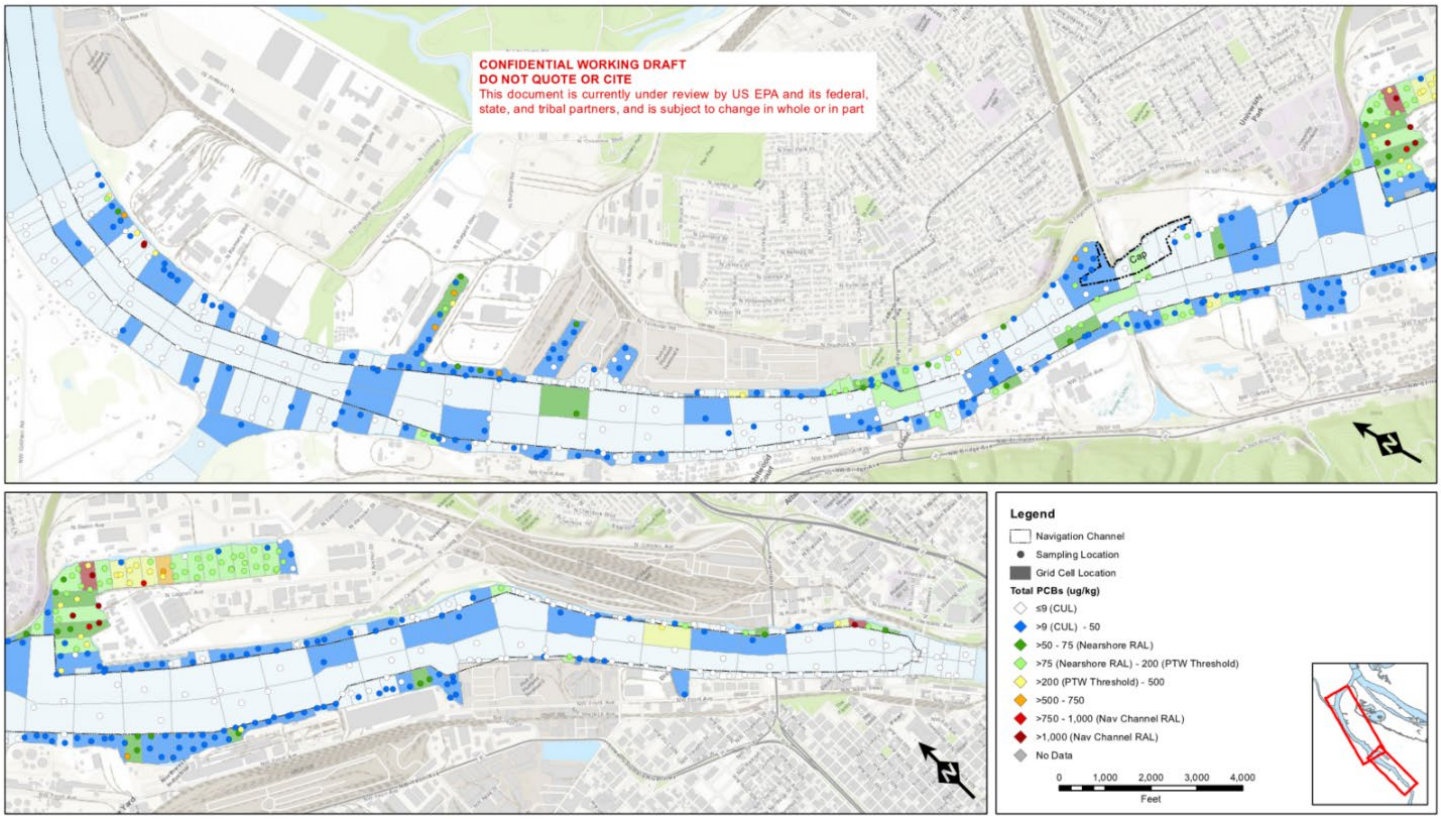


December 6, 2019

Achievability of Cleanup Levels

- CULs for some COCs are based on background (upstream) concentrations; others are risk or ARAR based
  - Sediments are remediated to remedial action levels (RALs), which are higher than CULs.
  - CULs are intended to be met by natural recovery after active remediation.
  - Active remediation will be finished about 20 years from now. Since source control, remediation, and natural recovery of the upstream/background areas are ongoing, the background/upstream concentrations are likely to change.
  - If background based CULs are to be updated, they should be updated when they are needed (post-remediation) as part of the five-year review process.
- Analysis of the PDI data suggests that the current ROD CULs are achievable
- PDI surface sediment samples in the site less than CULs:
  - PCBs: 44% of samples < CUL **See illustrated example below**
  - PAHs: 95% of samples < CUL
  - DDx: 64% of samples < CUL
  - TCDD: 52% of samples < CUL
  - PeCDD: 39% of samples < CUL
  - PeCDF: 37% of samples < CUL
  - Other ROD Table 17 COCs: 13% to 100% of samples < CUL
- PDI surface water samples less than CULs:
  - ROD Table 17 COCs: 13 of 27 surface water COCs < CULs for all samples in the site
- Fish tissue target levels are not enforceable CULs
  - Meant to inform institutional controls such as fish consumption advisories

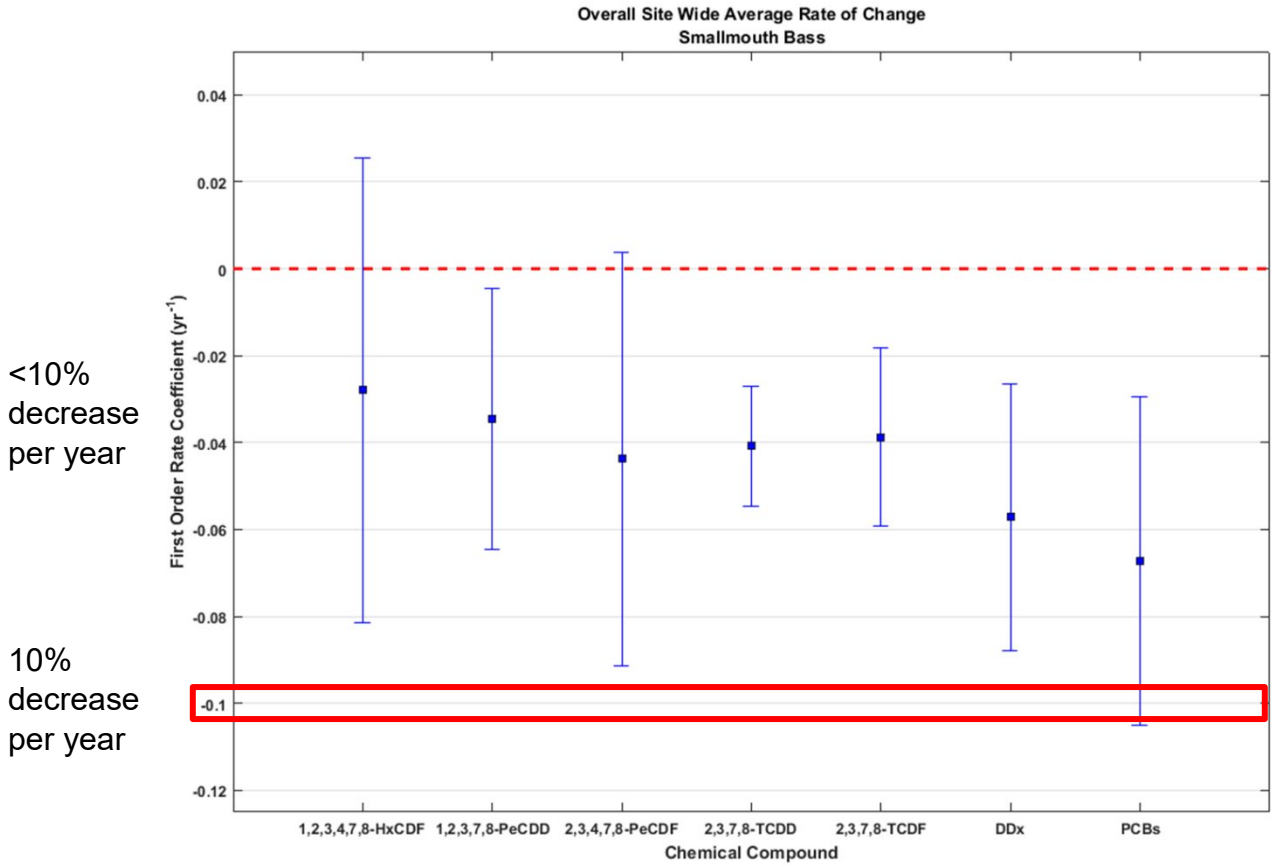
Illustrated Example: Distribution of Surface Sediment Chemistry for Total PCBs. White = < CUL (< 9 µg/kg)



Fish Tissue Recovery Analysis

- EPA evaluated smallmouth bass tissue concentration changes from 2002 to 2018 at sitewide and smaller river segment scales **(entire dataset used)**
- Different sampling programs during each sampling event present uncertainty with trend analysis
  - RI data consisted of composite samples (2002 and 2007)
  - Newer datasets were individual specimens and had more samples (2012 and 2018)
  - Sampled fish locations are different between sampling years (fish are caught using rod and reel) and replication of sample locations is highly challenging or not attempted
  - Each year presents average concentrations of fish captured throughout the 10-mile site, but the fish in that average were captured from different locations.
  - Similar to sediment SWAC comparisons, this uncertainty does not preclude a comparison of averages, rather that change estimates are uncertain (not quantitatively accurate)
- The analyses estimate sitewide annual declines in tissue concentrations between approximately 3 and 7%, depending on the COC. **See illustrated example below**
- There is greater variability at smaller spatial scales due to heterogeneity in tissue concentrations
- Concentration decreases are indicative of natural recovery and source control
- It is anticipated that active remediation will generate greater declines faster (e.g., Lower Fox River, Kalamazoo River)

Illustrated Example: Smallmouth Bass Fish Tissue Temporal Change Evaluation

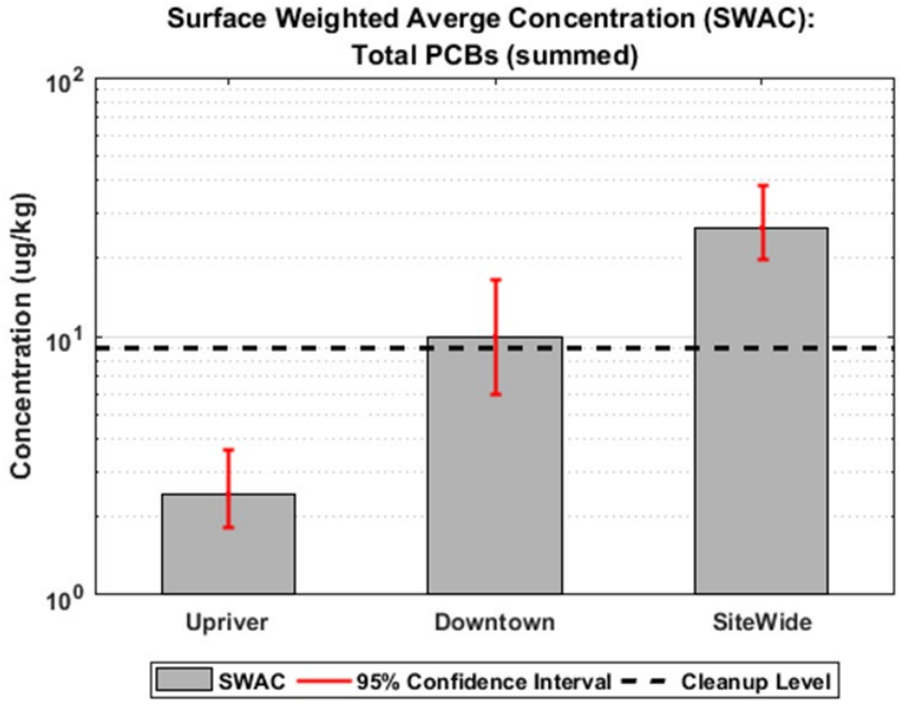


Background Concentrations and Associated Cleanup Levels

Item Number 1c from Pre-RD Group November 19, 2019 Letter

- The background reference area in the ROD is the Upriver Reach from river miles (RMs) 16.6 to 28.4. The Portland Harbor site (RMs 1.9 to 11.8) and the Downtown Reach (RMs 11.8 to 16.6) are both downstream and managed by EPA and the Oregon DEQ, respectively.
- The ROD selected sediment CULs based on background (Upriver Reach) concentrations when the risk-based values were less than background. This is a policy decision to make sure that parties don't have to cleanup to lower than background.
- Background-based CULs include arsenic (3 mg/kg), PCBs (9 µg/kg), and four dioxins/furans – HxCDF (0.004 µg/kg), PeCDD (0.0002 µg/kg), PeCDF (0.0003 µg/kg), and TCDD (0.0002 µg/kg).
- Background-based CULs are not expected to be met until after active remediation, which likely will be 20 years from now. At that time, the upstream background concentrations should be reviewed to assess whether the background-based CULs should be updated.
- The Pre-RD Group performed a background porewater study "to inform the background metals transition zone/porewater concentrations of arsenic and manganese."
    - None of the porewater samplers achieved equilibrium with the surrounding environment
    - Additional study is warranted to develop appropriate background based CULs
- The PDI surface sediment data confirm that the background CULs are appropriate for the focused COCs when outlier samples (collected near source control areas) are removed.
    - Follows methodology used in ROD and expects that identified source control areas will be remediated under ODEQ's cleanup program.
    - The PDI data Upriver Reach SWAC and 95% upper confidence limit for total PCBs is less than the ROD background CUL. **See illustrated example below**

Illustrated Example: Total PCBs Sitewide, Downtown Reach, and Upriver Reach SWACs with 95% Confidence Intervals Compared to ROD CUL (9 µg/kg).



PDI Data and Use in Health Risk Assessments

- Human consumption of resident fish is the most significant risk driver at the site
- This risk was evaluated in the baseline human health risk assessment (BHHRA) as part of the RI
    - Three fish consumption scenarios based on regionally appropriate or adjusted studies:
        - Recreational: 49 g/d over 30 years (decided in 2012 BHRRA dispute)
        - Subsistence: 142 g/d over 30 years (decided in 2012 BHHRA dispute)
        - Tribal: 175 grams per day (g/d) over 70 years (50% resident and 50% migratory fish)
    - Multi-species diet consisting of smallmouth bass, carp, brown bullhead, and black crappie
    - Tissue concentrations highest in carp, lowest in black crappie, and in-between for brown bullhead and smallmouth bass (SMB); samples composited at different spatial scales
    - Sitewide risk evaluated with data from all four resident species
    - Risk on a river mile scale evaluated with smallmouth bass tissue data because their home range is an approximate midpoint of the site resident species
- Highest risks from fish consumption (i.e., highest tissue concentrations) collocated with highest sediment concentrations
- Pre-RD Group only evaluated risk at sitewide scale by assigning the 2018 SMB concentrations (whole body or estimated fillet) to the multi-species diet (fish that were not sampled)
    - Used fish consumption scenarios with lower rates than the HHRA to lessen site risk
- Oregon DEQ evaluated fish consumption risk using PDI and RI/FS data **(entire dataset used)**
    - Reduction in risk less than 10% from BHHRA **See illustrated example below**

Illustrated Example: Calculated PCB Risk Using RI/FS and PDI Data Compared to BHHRA and PDI

		2013 BHHRA[a]			DEQ Approach with 2018 Data		PDI (RI/FS Scenario)[d]	
	Exposure Scenario[b]	EPC[c] (µg/kg)	Calculated Risk	Source	EPC[c] (µg/kg)	Calculated Risk	EPC[c] (µg/kg)	Calculated Risk
Excess Cancer Risk	Tribal WB	2,900	2E-02	Table 5-63	2,800	2E-02	358	2E-03
	Tribal F	2,500	1E-02	Table 5-63	2,500	1E-02	93	5E-04
	Subsist. F	5,000	1E-02	Table 5-74	4,900	1E-02	606	2E-04
	Rec. F	5,000	4E-03	Table 5-74	4,900	4E-03	76	6E-05
Child Hazard Quotient	Tribal WB	2,900	700	Table 5-61	2,900	700	358	87
	Tribal F	2,500	600	Table 5-61	2,500	600	93	23
	Subsist. F	5,000	1,000	Table 5-67	4,900	1,000	606	15
	Rec. F	5,000	300	Table 5-67	4,900	100	76	5
Infant Hazard Quotient	Tribal WB	2,900	9,000	Table 5-64	2,900	9,000	358	NC[f]
	Tribal F	2,500	8,000	Table 5-64	2,500	8,000	93	NC
	Subsist. F	5,000	10,000	Table 5-76	4,900	10,000	606	NC
	Rec. F	5,000	4,000	Table 5-76	4,900	4,000	76	NC

Notes:

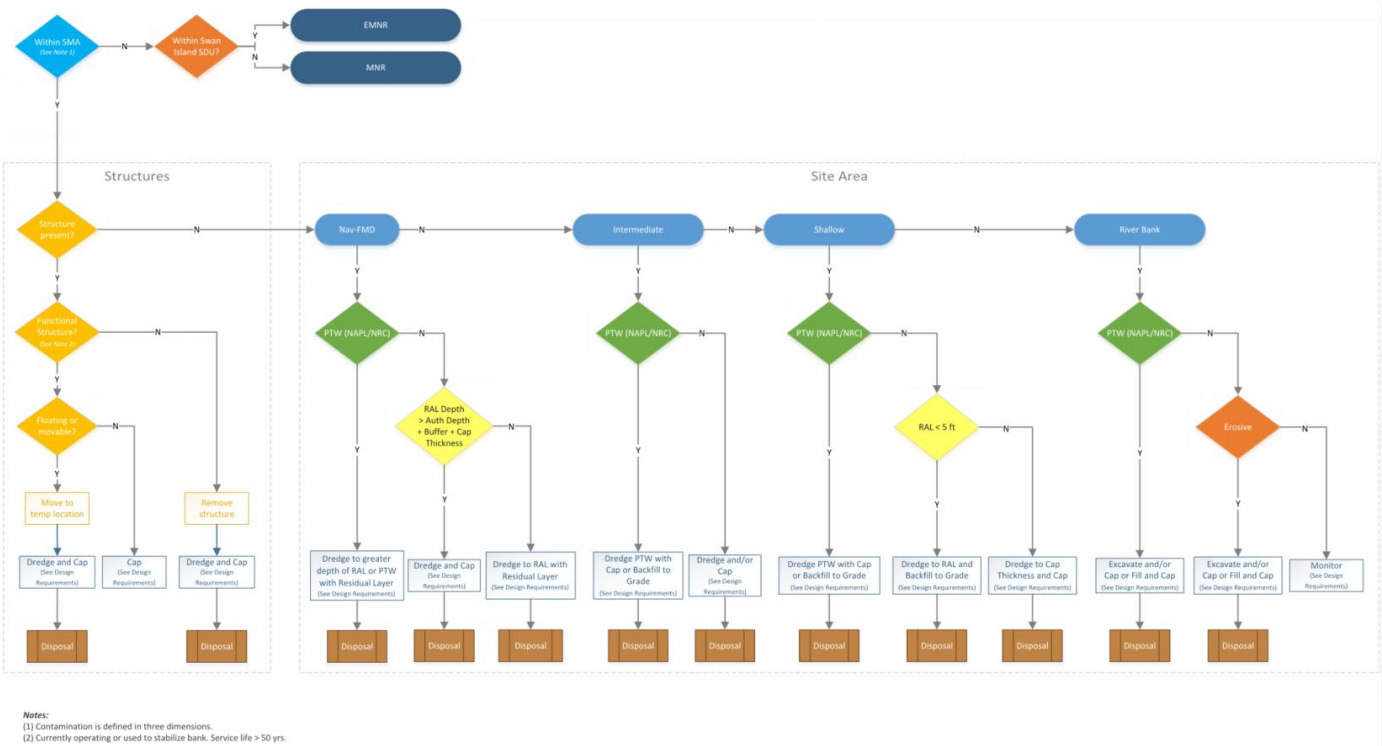
a) Portland Harbor Final Remedial Investigation Report, Appendix F, Baseline Human Health Risk Assessment
b) WB = whole body; F = fillet; Subsist. = subsistence fisher; Rec. = recreational fisher
c) EPC = exposure point concentration; Data from Tables B-2 and B-3.
d) Pre-remedial Design Investigation, Appendix G, Table 5. Because risks shown here are only for PCB, total risks shown in Table 2.6 of the PDI report are higher.
e) PCB adjusted congener concentration (non-dioxin like)
f) NC = not calculated

Differences in ROD and Pre-RD Group Decision Trees

Item Number 1b from Pre-RD Group November 19, 2019 Letter

- There are two primary differences between the ROD and Pre-RD Group technology assignment decision trees:
  - The Pre-RD Group recommends the use of enhanced natural recovery (ENR), which is the placement of a 6" sand layer, within the SMAs. The ROD does not allow ENR within the SMAs.
  - The Pre-RD Group decision tree includes technology selections that assume site-specific conditions. The ROD decision tree is more general to allow the site-specific conditions to be fully evaluated within remedial design. **See illustrated example below**
- At sediment sites, ENR is typically used as a cleanup technology in areas of lower contamination and as a dredge residual management layer.
  - ENR doesn't isolate contaminants like an engineered cap does but rather helps with natural recovery through burial/dilution.
  - The FS technology screening process found that ENR works best where the source of contamination has been removed.
  - The Pre-RD Group do not present any supporting information as to why ENR should be considered as a cleanup technology within SMAs.
- The Pre-RD Group decision tree includes technology selections that assume site-specific conditions such as capping without dredging in the navigation channel/future maintenance dredge areas.
  - The Pre-RD Group decision tree includes footnotes that describe how their technology selections could be precluded under certain conditions.
  - Site-specific conditions such as land use, deposition/erosion, slope stability, etc. need to be determined during remedial design to select the appropriate technology.

Illustrated Example: ROD Technology Application Decision Tree

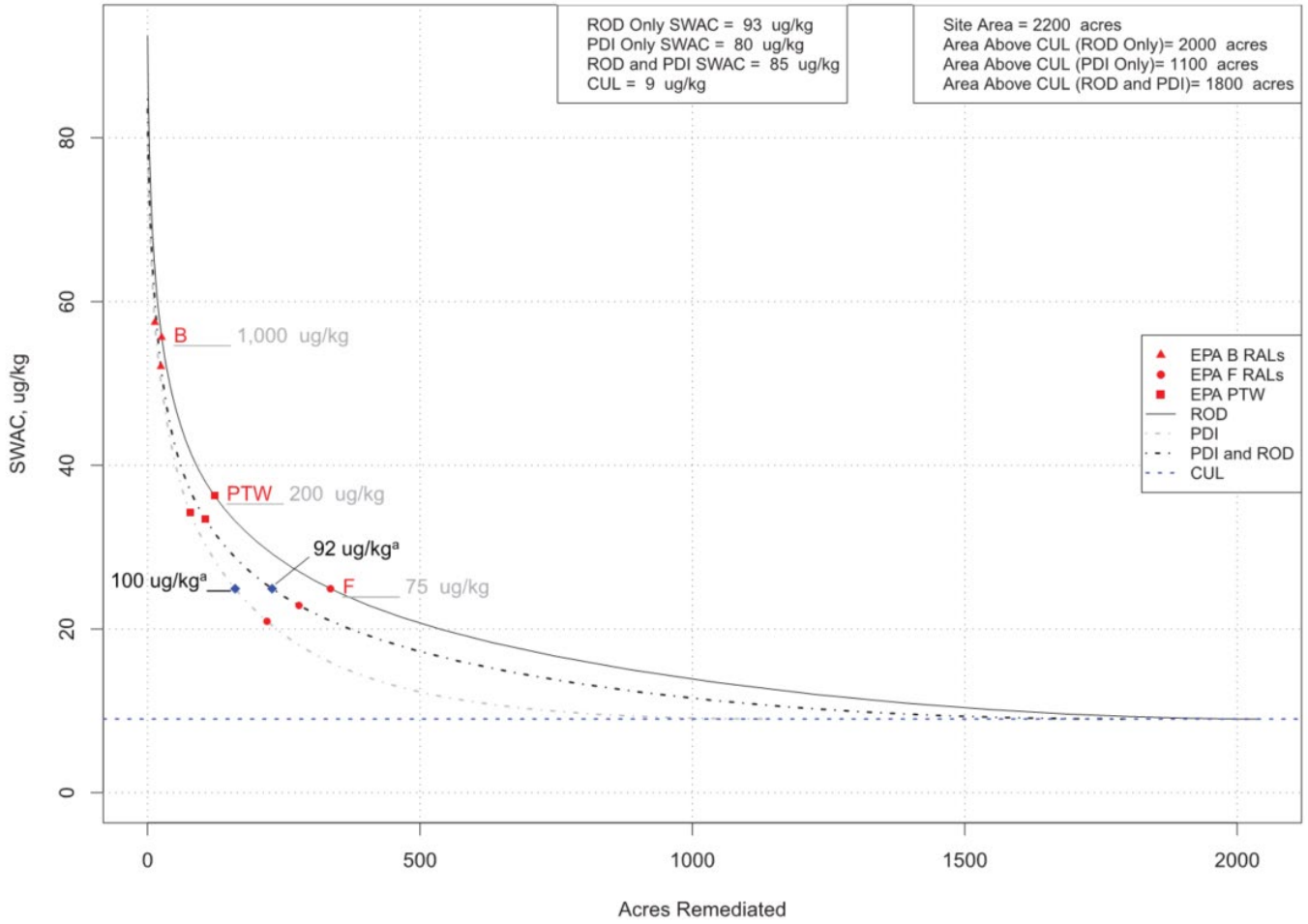


Remedial Action Levels

Item Number 1a from Pre-RD Group November 19, 2019 Letter

- Remedial action levels (RALs) are threshold concentrations used to determine when contamination needs to be actively remediated or can be allowed to recover naturally.
    - RALs are not risk-based concentrations and are higher than the cleanup levels
- RALs are a risk management tool. At Portland Harbor, a "RAL curve" was developed to assist in RAL selection. The curves help to visualize various RALs and their impact on site SWAC and acres remediated.
    - Each point on the curve represents a post-construction SWAC and the contaminant concentration that must be removed to achieve the associated SWAC.
- There are not specific rules or guidance on how to develop RALs or select RALs from a RAL curve. In general, these types of curves identify the areas of the curve where there is a maximum or minimum change in the SWAC to acres remediated relationship.
- The Pre-RD Group used only the PDI data in their RAL estimates using RAL curves
- EPA's RAL curves found that the ROD RALs are still reasonable thresholds for active remediation when evaluating the PDI data alone or with the RI/FS data. **See illustrated example below**
    - The PDI data do not result in significantly different RALs or post-construction SWACs.

Illustrated Example: Total PCBs RAL Curve for the RI/FS (ROD) Data, PDI data, and Combined (ROD and PDI)

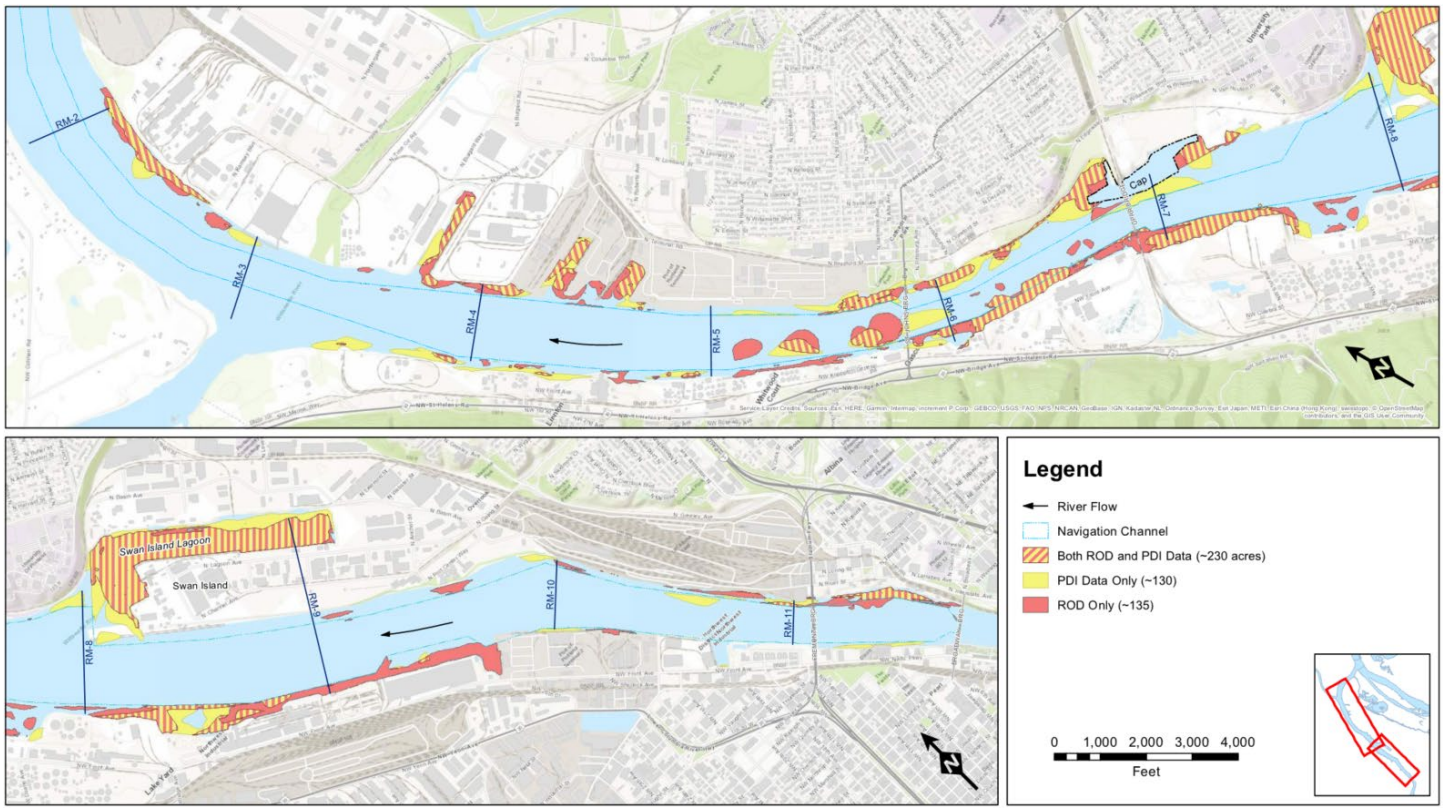


Note: (a) The blue diamonds represent the RAL that would be needed for the PDI Only and ROD and PDI datasets to achieve an equivalent post-construction SWAC (24.9 ug/kg) as the ROD Only dataset. These are not proposed or selected RALs and are only provided for illustrative purposes.

Sediment Management Areas

- The sediment management areas (SMAs) are the portions of the site greater than RALs that present the greatest risk to humans and ecological receptors.
    - The ROD provided an initial map of the SMAs developed using the RI/FS surface sediment data.
    - The ROD envisioned that SMAs would be updated based on higher density samples in both the surface and subsurface sediment (i.e., three dimensions) collected during remedial design.
    - The ROD also anticipated that the size of the SMAs could change due to natural recovery that has taken place since RI/FS data collection.
- There are not enough PDI samples to fully delineate the SMAs for remedial design. However, SMAs can be mapped from the PDI data for qualitative comparisons with the ROD SMAs.
- EPA and Pre-RD Group SMA footprints:
    - EPA ROD SMAs (RI/FS data only): 365 acres
    - EPA PDI SMAs (PDI data only): 360 acres
    - EPA ROD & PDI SMAs (RI/FS and PDI combined datasets): 375 acres **(entire dataset used)**
    - Pre-RD Group 6 focused COC SMAs (PDI data replacing historical data within 100 ft): 143 acres
    - Pre-RD Group 3 focused COC SMAs (PDI data replacing historical data within 100 ft): 111 acres
- EPA's evaluations with the PDI data found that the SMAs are approximately the same size and in the same locations as those in the ROD.
- The Pre-RD Group's SMAs differ because they used higher RALs, replaced historical samples within 100 ft of a PDI sample, and did not include principal threat waste.

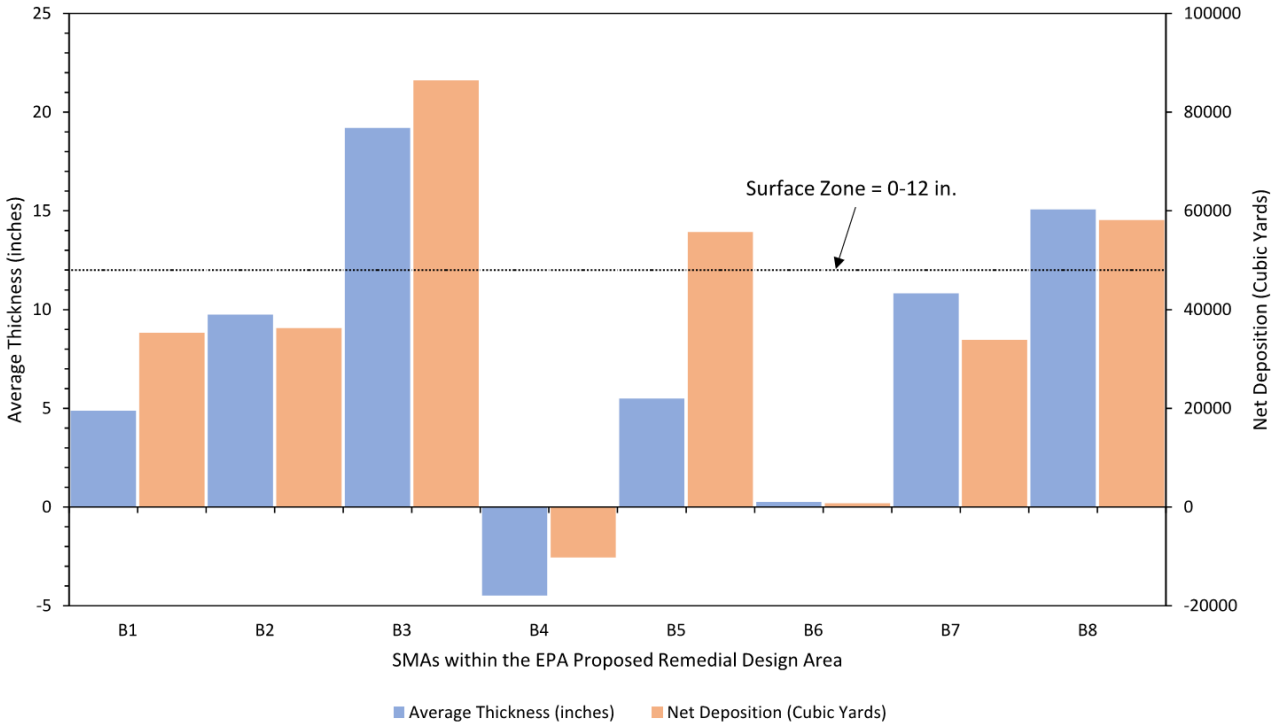
Illustrated Example: ROD Remediation Area and PDI Data Remediation Area



Monitored Natural Recovery

- Monitored natural recovery (MNR) is an essential component of the selected remedy and encompasses the majority of the sitewide remedy.
    - The primary mechanism for natural recovery at Portland Harbor is deposition of clean sediment
- The technology assignments selected in the ROD and acres to be remediated are as follows:
    - MNR: 1,774 acres (81.9% of total site area)
    - Enhanced natural recovery (ENR): 28.2 acres (1.3%)
    - Capping: 117.8 acres (5.4%)
    - Dredging: 215.5 acres (9.9%)
    - Dredge and cap: 32.3 acres (1.5%)
- The effectiveness of MNR was evaluated in the FS through a multiple lines of evidence approach including: (1) Deposition and erosion rates, (2) Consistency of depositional and erosional processes, (3) Sediment grain size, (4) Anthropogenic factors such as propeller wash and maintenance dredging, (5) Subsurface to surface sediment concentration ratio, and (6) Wind and wake generated waves
- The PDI data show that the depositional and erosional areas as well as the consistently depositional and erosional process areas are consistent with those from the RI/FS **(entire dataset used)**
- The PDI surface sediment data show that concentrations of the focused COCs are decreasing in the MNR areas but not in the SMAs
    - Corroborated by the fact that most SMAs received on average less than 1 foot of new sediment since 2004. **See illustrated example below**
- The Pre-RD Group's proposed expansion of MNR to up to 95% of the total site area substantially increases the area of the site that is reliant on natural recovery as the final, protective remedy and that determination is not supported by data or evaluations. The much longer time to get to acceptable risk is not supported by the public, the State, or the Tribes based on comments received on the PDI report.

Illustrated Example: Average New Sediment Thickness and Net Deposition in the ROD SMAs 2004 to 2018



Sediment and Fish Tissue Relationship

- Many of the COCs at Portland Harbor are bioaccumulative and increase in concentration for species higher in the food chain.
    - Organisms get exposed to contamination in sediment through direct contact with sediment, ingestion of sediment particles and prey species, and direct contact with dissolved contaminants in porewater or surface water.
    - Predator fish such as smallmouth bass generally have higher COC concentrations in their tissue than smaller fish, clams, worms, or other species lower in the food chain.
- During the RI/FS, a peer-reviewed mechanistic food web model was used by the responsible parties and adapted using site data to understand the relationship between COC concentrations in sediment, water, and biota at Portland Harbor.
    - The mechanistic food web model was used to develop risk-based sediment PRGs for PCBs, dioxins/furans, and chlorinated pesticides/herbicides.
    - There is a positive relationship between concentrations in sediment and biota such that as sediment concentrations increase biota concentrations also increase.
- The Pre-RD Group concluded in their PDI Evaluation Report that there is no spatial relationship between sediment and fish tissue and the RI/FS mechanistic food web model is invalid.
- EPA's evaluations found that for PCBs, DDx, and dioxins/furans there is a significant relationship between sediment and fish tissue concentrations at distances less than 600 feet **(entire dataset used)**
    - This relationship is clearly seen when mapped. **See illustrated example below**
- Pre-RD Group's evaluations do not support their conclusion that the food web model is invalid.

Illustrated Example: Distribution of Fish Tissue and Sediment Concentrations for Total PCBs